SMALL *POGONA VITTICEPS* (REPTILIA: AGAMIDAE) FROM THE BIG DESERT, VICTORIA, WITH NOTES ON OTHER *POGONA* POPULATIONS

GEOFFREY J. WITTEN[1] AND A. JOHN COVENTRY[2]

[1]Department of Anatomy and Physiology, Phillip Institute of Technology, Plenty Road, Bundoora, Victoria 3083
[2]Division of Natural History, Museum of Victoria, 285 Russell Street, Melbourne, Victoria 3000

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Adults of *Pogona vitticeps* are smaller towards the southern limit of the distribution of the species, the smallest animals occurring in the Big Desert in western Victoria. Females are not markedly smaller at sexual maturity than males, but males mature at a much smaller size. Data from *P. barbata* suggest that early male maturity in southern areas may occur also in that species. Relative growth and external morphology indicate that the Big Desert population is not taxonomically distinct from *P. vitticeps*. Factors causing the reduced size of animals in the population are unknown.

A POPULATION of *Pogona* lizards from the Big Desert mallee heath in western Victoria has been extensively studied as part of an ongoing project. These lizards closely resemble *P. vitticeps* (Ahl) but are much smaller. *P. vitticeps* typically grows to 250 mm snout-vent length (SVL) (Badham 1976), but the largest specimen collected from the Big Desert is a male of 175 mm SVL (NMV D54760). Morphological features of this population of clearly smaller animals were examined to establish its taxonomic status.

METHODS

Measurements and meristic characters were recorded from museum specimens (see Appendix). Limb, snout–vent and tail lengths were measured to the nearest 0.5 mm using a perspex-mounted ruler. Smaller measurements were taken using dial calipers accurate to 0.05 mm. Where possible, measurements were made bilaterally and the mean used in analysis. Head depth was measured through the centre of the orbit and the maximum head width was also recorded. Other measurements are self-explanatory.

Morphometric data were analysed by calculating the least squares regression for measurements first converted to natural logarithms, allowing the calculation of Huxley's formula for relative growth:

$$Y = bX^a$$

where Y is the measurement under consideration, X the SVL, b a constant and a the allometric coefficient. These regressions were used to calculate theoretical measurements in hatchlings (45 mm SVL) and in adults near the maximum size of specimens in the Big Desert population (150 mm SVL).

Gonad size and condition were also recorded. Females were considered to be mature if they had oviducal eggs, convoluted opaque oviducts or ovarian follicles more than 5 mm in diameter. Males were assumed to be mature if their testes were enlarged and circular in cross-section. If testicular regression occurs in this species it does not alter the gross appearance of the testes; all males of adult size had apparently mature testes.

Comparisons were made between four groups of specimens: *P. vitticeps* from the Big Desert; *P. vitticeps* from the "Sunset Country" (north-western Victoria north of the Big Desert); *P. vitticeps* from elsewhere (including South Australia, New South Wales, Queensland and the Northern Territory); and *P. barbata*.

RESULTS

Sexual maturity and size

Animals from the Big Desert are clearly smaller than those from the Sunset Country (T-test $P < 0.005$), which are in turn smaller than those from elsewhere ($P < 0.001$) (Table 1).

The smallest Big Desert female with oviducal eggs was 121 mm SVL (NMV D54754), and the smallest female with opaque, convoluted oviducts (indicating previous egg production) was 132 mm SVL (NMV D54051). The largest clearly immature female examined (NMV

Population	Females N	Mean	(SD)	Range	Males N	Mean	(SD)	Range
Big Desert	9	130.8	(13.9)	113–163	11	126.5	(30.2)	83–175
Sunset Country	8	157.5	(28.6)	126–202	6	157.8	(19.4)	131–181
Others	6	184.3	(31.5)	132–217	8	229.0	(16.0)	208–247

Table 1. Size of mature *Pogona vitticeps*.

D55064, 61 mm SVL) has ovarian follicles less than 0.4 mm in diameter. Big Desert females more than 92 mm SVL have ovarian follicles more than 1 mm in diameter. One of these specimens (NMV D54759) has follicles of 6.5 mm diameter and a SVL of 113 mm; this was the smallest female that was clearly mature. Some larger mature females had ovarian follicles of less than 2 mm diameter.

Specimens of *P. vitticeps* from outside the Big Desert mature at a larger size but the difference is not great. A female recorded as coming from "Gawler Ranges, Victoria" (but probably from South Australia; NMV D648) has opaque convoluted oviducts at 128 mm SVL, and a female from near Hattah in northern Victoria was gravid at 126 mm SVL (NMV D11754). Two specimens recorded as coming from Ouyen provide data of dubious significance. One of them (NMV D1031) was clearly immature at 97 mm SVL, having ovarian follicles of less than 1 mm diameter. The other (NMV D970) is only 114 mm SVL yet has opaque convoluted oviducts. Ouyen is north-east of the Big Desert but is the nearest major centre of population east of the desert. The specimens are unlikely to have been collected from the township itself, and either or both of them may have come from the Big Desert or from the Sunset Country. Data from these specimens were excluded from all analyses.

Males from the Big Desert clearly mature at a smaller size than those from elsewhere. One specimen (NMV D18220, 83 mm SVL) has testes approaching 7 mm in length, and another of similar size (NMV D53836, 85 mm SVL) also has larger testes than immature animals (5.6 mm). In comparison, two males of *P. vitticeps* from Purnong in South Australia were immature at SVLs of 88 (NMV D4547; larger testis of 3.15 mm length) and 93 mm (NMV D3072; 4.0 mm). Another specimen from Broken Hill (NMV D52089) was not mature at a SVL of 132 mm, the larger of its testes being only 4.2 mm in length. In these immature specimens the testes are flattened, contrasting sharply with the swollen, more circular testes of mature animals.

Specimens of *P. barbata* from Victoria are not markedly smaller than those from populations elsewhere. A male from near Boort was 219 mm SVL (NMV D57127). However, a specimen from the south-west of the state (NMV D14699) was a mature male of 95 mm SVL (larger testis 7.45 mm), considerably smaller than the 130 mm stated for mature individuals of both sexes by Badham (1976).

Morphometrics

Data were analysed to quantify allometry in growth. Allometric growth for all populations of *P. vitticeps* is very similar (Table 2). The head of *P. vitticeps* is wider than that of *P. barbata*, especially in larger animals. A clear trend is apparent in the allometric data for head width, populations of larger animals having a higher allometric coefficient. For measurements apart from head width the different *P. vitticeps* populations do not differ substantially. The head is apparently larger in the populations of smaller animals, particularly in juveniles (Table 2).

External morphology

Scale counts and other characters are very similar in specimens of *P. vitticeps* from the Big Desert and from elsewhere (Table 3). A nuchal scale ridge formed by a few mucronate scales with their keels aligned is commonly present in all populations, this ridge continuing well onto the trunk in some animals from the Big Desert population. Individuals from the Big Desert population also commonly possess a paravertebral nuchal scale ridge (about 75% of specimens examined), consisting of a row of mucronate scales parallel to the nuchal scale ridge but a few scales lateral to it. A similar scale row is reported in *P. minimus* (Badham 1976, fig. 4e). Other populations of *P. vitticeps* also commonly possess the paravertebral scale row but the nuchal scale row seldom continues posteriorly.

The venter of the Big Desert animals is commonly patterned in the ocellations typical of

Measurement	Big Desert *P. vitticeps* (N = 34) a	(SE)	X45	X150	Sunset County *P. vitticeps* (N = 28) a	(SE)	X45	X150	Other *P. vitticeps* (N = 31) a	(SE)	X45	X150	*P. barbata* (N = 35) a	(SE)	X45	X150
Tail	0.97	(0.026)	61.2	196.5	0.87	(0.024)	68.8	197.4	0.89	(0.029)	65.2	191.4	0.99	(0.025)	61.2	201.0
Head width	0.96	(0.029)	11.0	35.1	1.07	(0.034)	10.1	36.4	1.15	(0.038)	9.33	37.1	1.03	(0.035)	9.80	33.8
Snout-parietal	0.70	(0.012)	10.9	25.2	0.69	(0.015)	10.8	24.9	0.69	(0.016)	10.6	24.3	0.72	(0.013)	10.5	24.8
Snout-typanum	0.85	(0.016)	12.4	34.6	0.84	(0.018)	12.2	33.8	0.89	(0.018)	11.5	33.5	0.88	(0.014)	11.7	33.9
Head depth	0.80	(0.027)	8.35	21.8	0.78	(0.019)	8.06	20.6	0.87	(0.020)	7.34	20.9	0.83	(0.023)	7.39	20.0
Tympanum	0.87	(0.040)	1.97	5.65	0.87	(0.031)	1.93	5.49	1.00	(0.045)	1.72	5.72	1.00	(0.025)	1.98	6.65
Hindlimb	0.94	(0.014)	26.6	82.7	0.90	(0.015)	27.9	82.7	0.89	(0.016)	27.6	81.0	0.92	(0.015)	26.3	79.2
Pes length	0.83	(0.016)	11.8	32.3	0.79	(0.017)	12.4	32.1	0.81	(0.023)	11.8	31.1	0.84	(0.020)	11.2	30.9
Forelimb	0.90	(0.017)	19.4	57.5	0.92	(0.017)	19.6	59.4	0.89	(0.018)	20.3	59.3	0.92	(0.016)	19.3	58.2

Table 2. Allometric characters of *Pogona* populations; a = allometric coefficient; X45 = calculated length of the part at a snout-vent length of 45 mm; X150 = similar calculation at SVL of 150 mm.

Count	Big Desert *P. vitticeps* (N = 34) Mean	(SD)	Range	Sunset Country *P. vitticeps* (N = 17) Mean	(SD)	Range	Other *P. vitticeps* (N = 25) Mean	(SD)	Range	*P. barbata* (N = 26) Mean	(SD)	Range
PNS	4.94	(0.69)	4–6	5.24	(0.90)	4–7	4.64	(0.71)	3–6	4.62	(0.64)	4–6
SNS	4.29	(0.58)	3–6	4.29	(0.77)	3–6	4.52	(0.77)	3–6	4.12	(0.65)	3–5
INS	11.06	(1.2)	8–13	11.29	(1.1)	9–13	10.92	(1.1)	9–13	10.31	(1.0)	9–13
SPS	14.06	(1.1)	12–17	15.24	(1.9)	11–19	15.24	(1.8)	12–20	14.48	(1.6)	13–18
SOS	4.32	(0.47)	4–5	4.53	(0.51)	4–5	4.32	(0.48)	4–5	4.35	(0.49)	4–5
SLS	16.74	(1.1)	15–19	16.68	(1.1)	15–19	17.28	(1.1)	15–19	17.0	(1.2)	14–19
ILS	15.76	(1.2)	14–18	15.94	(1.1)	13–18	16.20	(1.2)	14–19	16.2	(1.2)	15–18
MBS	145.3	(11.8)	129–164	—	—	—	138.2	(10.6)	119–154	141.1	(15.6)	101–175
FPS	15.09	(2.0)	11–19	14.63	(1.5)	12–17	13.80	(2.2)	9–19	14.6	(2.1)	11–19
SDL	21.64	(1.3)	19–25	22.06	(1.1)	20–24	21.60	(2.0)	18–26	22.7	(2.0)	18–26

Table 3. Comparative scale and pore counts; PNS = prenasal scales; SNS = subnasal scales; INS = internasal scales; SPS = scales from rostral to interparietal; SOS = scales from lower border of orbit to supralabial series; SLS = supralabial scales; ILS = infralabial scales; MBS = mid-body scale rows; FPS = femoral pores (total); SDL = number of lamellae under fourth toe.

Pogona species. Badham (1976) reported that the venter of *P. vitticeps* was "rarely patterned except in juveniles". This colour pattern in the Big Desert animals is therefore interpreted as a neotenic character.

Sexual dimorphism

There is little size difference between the sexes (Table 1). Males are a little larger than females, significantly so in the non-Victorian specimens ($P = 0.011$). Limb and tail lengths are relatively greater in males, as noted by Badham (1976), and the head of males is relatively wider.

In Big Desert animals the tympanum alters in shape from almost circular in hatchlings to oval in adults. This change is much more pronounced in females and may be used with reasonable reliability to sex adults. This dimorphism is less pronounced in other *P. vitticeps* populations and is not apparent in *P. barbata*.

DISCUSSION

The broad head of *P. vitticeps* is a characteristic difference from other species of *Pogona* (Badham 1976), and the Big Desert population shares this character. In all head measurements, the calculated juvenile figures (X45, Table 2) for the Big Desert population are higher than those for other populations, but at adult size (X150, Table 2) the differences are negligible. This result is surprising because allometric coefficients are usually more labile than juvenile proportions (Witten 1985), and we can think of no adaptive explanation for it. It is possibly an artifactual result arising from earlier maturation in the Big Desert population.

The differences in scale and pore counts are of a magnitude to be expected from different populations of a single species. Although some differences exist, such as a lower number of scales from rostral to interparietal and a higher number of femoral pores in the Big Desert population, these are not great and fall far short of reasonable diagnostic characters.

The taxonomic status of the population from the Big Desert should remain unchanged. There is no evidence from any character examined which would support the erection of a new taxon to accommodate the population. Accordingly, it should be recognised as a population of *P. vitticeps* which fails to achieve large size. We have no evidence indicating whether the reduced size of the species in the Victorian mallee is genetic or phenotypic.

REFERENCES

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WITTEN, G. J., 1985. Relative growth in Australian agamid lizards: adaptation and evolution. *Australian Journal of Zoology* 33: 349–362.

APPENDIX

Specimens examined

All specimens are housed in the Museum of Victoria (NMV) or the Australian Museum (AM).

Big Desert *P. vitticeps*. NMV: D18220, D52637, D52690, D52742, D53482, D53827, D53836, D53853, D53907, D53925, D54051, D54070-1, D54123, D54131–2, D54144, D54557, D54749, D54754, D54759–60, D54789–90, D55036, D55064, D55251, D55305, D55583, D56741, D58501, D58548, D58555, D59448, D59818.

Sunset Country *P. vitticeps*. NMV: D699–700, D11753–4, D15379, D15382, D47858, D58472, D58477, D60324–5, D60609, D60694–5, D60708, D60741, D60760, D60762–3, D60768–9, D60778, D60785, D60826–8, D60841, D60854.

Other *P. vitticeps*. NMV: R4547–8, R13781–2, D1123, D3072, D8970, D12164, D14181, D41501–2, D52088–9, D58570. AM: R13904-5, R15295, R17122–3, R21077, R47319, R107398, R107406, R107409–10, R107444, (Field tags) 11252, 11350, 11358–9.

P. vitticeps not used in analysis. NMV: R4855, D648, D777, D787, D970, D1031, D1036, D7871.

P. barbata. NMV: D137, D151, D723, D744, D896, D966, D1345, D7934, D8038, D14034, D14036, D14679, D14699, D48900, D57127. AM: R17904, R20987, R21578, R25789, R107397, R107399–405, R107407-8, R107411–3, (Field tags) 11347–9, 11360.